M1. (a) accept any value between 12 (mm) and 13 (mm) inclusive

1

(b) to reduce the error in measuring the extension of the spring

accept length for extension throughout

1

as the ruler at an angle would make the measured extensions shorter

1

(c) 1 (N) to 6 (N)

accept from 0 (N) to 6 (N)

1

(d) gives a straight line through the origin

1

(e) any practical technique that would improve the accuracy of length measurement eg

use a set square

1

to line up the bottom of the spring with the ruler scale

or

attach a horizontal pointer to the bottom of the spring (1)

so that the pointer goes across the ruler scale (1)

1

(f) the spring has been inelastically deformed

1

because it went past its limit of proportionality

accept elastic limit for limit of proportionality

1

accept it does not go back to its original length when the weights are removed

[9]

M2. (a) **Z**

1

weight **or** mass acts through pivot

*accept rod **or** base for pivot*

accept centre of gravity in line with pivot

1

no (resultant) (turning) moment

accept clockwise moment equals anticlockwise moment

*do **not** accept same weight on each side of rod*

1

(b) (i) 30

*allow **1** mark for 2 × 15*

***or** 2 × 0.15*

2

N cm

or

for full credit the unit must be consistent with the numerical answer

0.3

Nm

*do **not** accept joules*

1

(ii) 1.5 (N)

*allow **1** mark for correct transformation*

*allow **2** marks ecf their part (b)(i)/20 (ecf only if correct physics)*

2

(c) 5 (cm)

*allow **1** mark for 6.0 (cm)*

*allow **1** mark for a subtraction of 1 from a value clearly obtained from the graph*

*allow **2** marks for correct ecf using an incorrect value for (b)(i) ± 0.2cm*

*allow **1** mark for clearly showing correct use of graph using an incorrect value for (b)(ii)*

2

[10]

M3. (a) Third Law

1

(b) elastic potential

1

(c) weight = mass × gravitational field strength

accept gravity for gravitational field strength

1

accept W = mg

accept correct rearrangement ie mass = weight / gravitational field strength ***or*** *m = W / g*

(d) 343 = m × 9.8

1

$m = \frac{343}{9.8}$

1

m = 35

1

allow 35 with no working shown for ***3*** *marks*

(e) force = spring constant × compression

accept force = spring constant × extension

accept F = k e

accept correct rearrangement ie constant = force / extension ***or*** *k = F / e*

1

(f) compression = 0.07m

1

343 = k × 0.07

1

k = 343 ÷ 0.07

1

k = 4900

1

*allow 4900 with no working shown for **4** marks*
*allow 49 with no working shown for **3** marks*

[11]

M4. (a) (i) **B C**

either order

1

(ii) elastic potential (energy)

accept strain for elastic

1

(b) (i) *mark both parts together*

1

measured / recorded the length of the spring (and not extension)

*accept measured **A–C** (and not **B–C**)*

accept did not work out/measure the extension

extension does not equal zero when force = 0

accept line should pass through the origin

1

(ii) point marked at 5.5 (N)

accept any point between 5.0 and 5.6 inclusive

1

up to that point force and extension are (directly) proportional

accept it's at the end of the straight part (of the graph line)

accept past that point force and extension are no longer (directly) proportional

accept the line starts to curve

1

(c) 1.8

*allow **1** mark for correct substitution, ie 25 x 0.072 provided*

no subsequent step shown

*an answer 1800 gains **1** mark*

*an incorrect conversion from mm to m with a subsequent correct calculation gains **1** mark*

2

[8]

M5. (a) (i) any **two** from:

- length of coils increased
- coils have tilted
- length of loop(s) increased
- increased gap between coils
- *spring has stretched / got longer*
- *spring has got thinner*

2

(ii) remove mass

accept remove force / weight

1

observe if the spring returns to its original length / shape *(then* it is behaving elastically)

1

(b) (i) 8.0 (cm)

1

extension is directly proportional to force *(up to 4 N)*

for every 1.0 N extension increases by 4.0 cm (up to 4 N)

evidence of processing figures eg 8.0 *cm* is half way between 4.0 *cm* and 12.0 *cm*

1

allow spring constant (k) goes from to $\frac{1}{4}$ to $\frac{5}{22}$

1

(ii) any value greater than 4.0 N and less than or equal to 5.0 N

1

the increase in extension is greater than 4 cm per 1.0 N (of force) added
dependent on first mark

1

(c) (i) elastic potential energy

1

(ii) misread stopwatch

1

timed too many complete oscillations

1

(iii) 4.3 (s)
accept 4.33 (s)

1

(iv) stopwatch reads to 0.01 s

1

reaction time is about 0.2 s
or
reaction time is less precise than stopwatch

1

(v) use more masses

1

smaller masses eg 50 g
not exceeding limit of proportionality

1

[17]